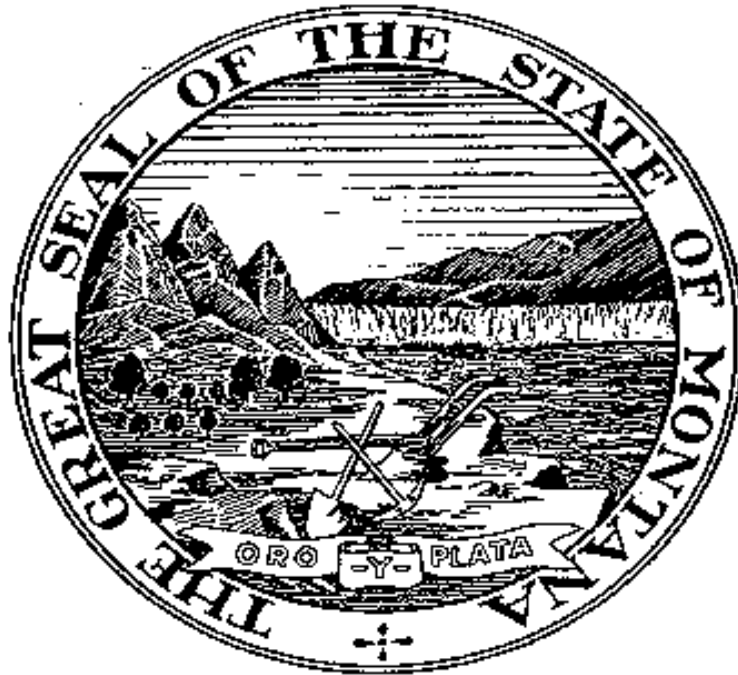


# **Diesel Exhaust Health Hazards**

**Occupational Safety & Health Bureau**



**Montana Department of Labor & Industry**

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by the

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# Diesel Exhaust Health Hazards

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## Introduction

Diesel exhaust is a pervasive airborne contaminant in workplaces where diesel-powered equipment is used. Due to expanding use of diesel equipment, more and more workers are exposed to diesel exhaust. Workers exposed to diesel exhaust face the risk of adverse health effects ranging from headaches to nausea to cancer and respiratory disease.

In addition to occupational exposure, the wide use of diesel engines in transportation provides significant opportunity for environmental exposure to these emissions. Currently available control technology could significantly limit many diesel exhaust exposures.

Diesel engines are used by an increasing number of automobiles, generators, light-duty and heavy-duty vehicles, and railroad locomotives. When diesel fuel burns in an engine, the resulting exhaust is made up of soot and gases which may contain thousands of different chemical substances.

The soot consists of very small *particles* that can be inhaled and deposited in the lungs. Diesel exhaust contains 20-100 times more particles than gasoline exhaust. These particles carry cancer-causing substances known as *polynuclear aromatic hydrocarbons (PAHs)*. *Gases* in diesel exhaust, such as nitrous oxide, nitrogen dioxide, formaldehyde, benzene, sulfur dioxide, hydrogen sulfide, carbon dioxide, and carbon monoxide can also create health problems.

Those most likely to be exposed to diesel exhaust include miners, railroad, bridge, tunnel, and loading dock workers, auto mechanics, truck and forklift drivers, and people who work near areas where these vehicles are used, stored or maintained.

## I. Health Effects of Diesel Exhaust

### A. Short-Term (Acute) Effects

Workers exposed to high concentrations of diesel exhaust have reported the following short-term health symptoms:

- irritation of the eyes, nose, and throat
- lightheadedness
- a "high" feeling
- heartburn
- headache
- weakness, numbness, and tingling in extremities
- chest tightness
- wheezing
- vomiting

### B. Long-Term (Chronic) Effects

Although there have been relatively few studies on the long-term health effects of diesel exhaust, the available studies indicate that diesel exhaust can be harmful to your health. According to the National Institute for Occupational Safety and Health (NIOSH), human and animal studies show that diesel exhaust should be treated as a human *carcinogen* (cancer-causing substance). These findings are not surprising since several substances in diesel exhaust are known to cause cancer. It may take many years after the first exposure for diesel-related cancer to develop.

Exposure to diesel exhaust in combination with other cancer causing substances may increase your risk of developing lung cancer even more. Other exposures that are known to cause lung cancer include cigarette smoke,

welding fumes and asbestos. All of these exposures may interact with diesel exhaust to magnify your risk of lung cancer, and should be kept to a minimum.

Some studies have suggested that workers exposed to diesel exhaust are more likely to have *chronic respiratory symptoms* (such as persistent cough and mucous), bronchitis, and reduced lung capacity than unexposed workers. People with preexisting diseases, such as emphysema, asthma, and heart disease, may be more susceptible to the effects of diesel exhaust.

Studies in animals suggest that diesel exhaust may have other effects as well:

- Mice developed *skin cancer* when extracts of diesel exhaust were applied to their skin.
- Diesel exhaust caused lung injury in exposed laboratory animals.
- Exposure to diesel exhaust reduced animals' resistance to bacterial infection.
- Laboratory animals exposed to high concentrations of diesel gases showed *a reduced level of activity and coordination*.

In addition, many of the individual components of diesel exhaust are known to be hazardous. For example, *nitrogen oxides* can damage the lungs, and *carbon monoxide* can aggravate heart disease and affect coordination. The particles in diesel emissions are known as “diesel particulate matter” (DPM). DPM is small enough to be inhaled and retained in the lungs. Below is a partial list of chemicals associated with diesel exhaust.

#### Major components

- Carbon dioxide
- Carbon monoxide
- Nitrogen dioxide
- Sulfur dioxide
- Particulates (PNOC)

#### Minor Components

- Acrolein
- O-Anisaldehyde
- Benzene
- 2,3-Benzofuran
- Coumarin
- Formaldehyde
- 4 – Hydroxycoumarin
- m-Hydroxyacetophenone
- 2-Hydroxy-4-methoxyacetophenone
- Menadione
- 6-Methoxytetralone
- 6-Methylcoumarin
- 3-Methyl-2-cyclopentene-2-ol-one
- Polynuclear aromatic hydrocarbons (PNHs)

## **II. Control of Diesel Exhaust**

### **A. Substitution**

Where possible, replace diesel engines with propane-burning engines. Propane burns more completely and more cleanly than diesel fuel. Try to purchase equipment with only low emission engines and replace older model engines with low-emission ones. Low-emission engines usually operate at high fuel injection pressures, which provides more efficient and complete combustion of fuel.

### **B. Ventilation**

Diesel exhaust in garages, warehouses, or other enclosed areas should be controlled using ventilation.

*Local exhaust ventilation* is the best way to reduce potential hazards to diesel exhaust. A good ventilation system should include both intake and exhaust fans that remove harmful fumes at their source. Tailpipe or stack exhaust hoses should be provided for any vehicle being run in a maintenance shop.

*General ventilation* uses roof vents, open doors and windows, roof fans, or floor fans to move air through the work area. This is not as effective as local exhaust ventilation, and may simply spread the fumes around the work area. General ventilation may be helpful, however, when used to supplement local exhaust ventilation.

### C. Isolate the Worker

Another way of controlling diesel exhaust exposures is to isolate the worker from diesel fumes.

- Trucks should have air-conditioned cabs to isolate the driver from fumes (Windows should be rolled up so that fumes do not seep inside).

### D. Safe Work Practices

Following the safe work practices below can also reduce exposure to diesel exhaust:

- Fuel grade 1K should be used instead of Diesel 1. Grade 1K is more expensive but burns more cleanly.
- Use fuel with low sulfur (<0.05% by mass) content, high cetane number (>48), and fuel additives (such as cetane improvers, oxygenated additives, and detergents).
- All diesel equipment should have regular maintenance and frequent tune-ups. The exhaust system should be checked for leaking fumes.
- A good preventive maintenance program will maintain near-original performance of an engine, and maximize vehicle productivity and engine life, while keeping exhaust emissions down. This should include daily vehicle checks of engine oil level, coolant, fuel and air filters, water tank, exhaust piping, and gauges.
- Vehicles should be fitted with emission control devices (air cleaners), such as collectors, scrubbers, and ceramic particle traps. Air cleaners should be checked regularly and replaced when they get dirty.
- Redirect diesel exhaust away from operators and other workers using an exhaust extender.
- Prolonged idling of machinery should be avoided. A worker should not be in the vehicle when it is idling for a long period.
- Any cracks in the vehicle should be fitted with weather stripping to prevent fumes from seeping in.
- The floor of the vehicle should not have any holes.
- Take care not to contaminate diesel fuel and lubrication oils during transfer. Contamination will increase emissions.
- Operators should avoid lugging the engine in too low RPM.

### E. Personal Protective Equipment

Respirators are usually the *least* effective method of controlling diesel exhaust exposures, and they should be used only as a last resort. For diesel exhaust, a combination air-purifying respirator that protects against acid gases, organic vapors, and particulate should be used.

It is not enough for your employer to toss you a respirator and tell you to go to work. Respirators must be specific to the hazard, and fitted, cleaned, stored, inspected, and maintained in accordance with OSHA's respirator standard (29 CFR 1910.134). In addition, you must be trained on how to use a respirator properly, and receive a medical exam to assure that you are physically fit to wear a respirator.

Prevent skin contact with diesel exhaust by wearing protective clothing (gloves, long pants, long-sleeved shirts, and face and eye protection) if necessary.

### F. Training

- Since the major mechanism for the control of diesel emissions is the proper operation of the engines, the training of maintenance personnel in their care and adjustment is a critical issue. All personnel involved in engine maintenance should thoroughly understand the maintenance procedures recommended by the engine manufacturer and should follow all preventative maintenance schedules.
- Equipment operators should be trained in the efficient use and care of the equipment.
  - Personnel who handle fuel and lubricating oils must be trained to prevent contamination from dust, water, or other sources.
  - Operators should be trained in routine inspection and maintenance.
  - Operators should be trained to avoid operating the engine at low RPM in high load situations ("lugging").
  - Engines should not be idled excessively.

- Personnel working with diesel fuel in areas where diesel exhaust may be present must be advised of the potential hazards of exposure.
- Workers that wear personal protective equipment must be trained on the use, care, and limitations of the equipment.

### III. OSHA Standards

There is no OSHA standard for diesel exhaust. However, OSHA does have workplace exposure limits for individual components of diesel exhaust, such as carbon monoxide, sulfur dioxide, benzene, carbon dioxide, nitrogen dioxide, acrolein, and formaldehyde.

In addition, OSHA has a standard for "nuisance" dust that is applicable to the soot in diesel exhaust. The standard limits "respirable" dust exposures (particles that are small enough to lodge in the lung) to 5 milligrams per cubic meter of air (5 mg/m<sup>3</sup>) averaged over eight hours.

Because diesel exhaust has been shown to cause cancer, the National Institute for Occupational Safety & Health (NIOSH) recommends that diesel exhaust exposures be reduced to the lowest feasible limits.

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### Resources

Additional information about occupational safety and health standards and regulations can be obtained from:

1. U.S. Department of Labor, **Occupational Safety & Health Administration, (OSHA)**. Public Affairs Office- Room 3647, 200 Constitution Ave., Ashington, D.C. 20210.  
Phone: 1-202-693-1999.  
[www.osha.gov](http://www.osha.gov)
2. **National Institute for Occupational Safety and Health, (NIOSH)**. Department of Health and Human Services,  
200 Independence Ave. SW 317B, Washington, DC 20201.  
Phone: 1-800-356-4674, 1-800-35-NIOSH  
[www.niosh.gov](http://www.niosh.gov)
3. **American Conference of Governmental Industrial Hygienists, (ACGIH)**.  
1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634.  
Phone: 1-513-742-2020, Fax: 1-513-742-3355  
[www.acgih.org](http://www.acgih.org)
4. **American National Standards Institute, (ANSI)**.  
11 West 42nd Street, New York, NY 10036.  
Phone: 1-212-642-4900, Fax: 1-212-398-0023  
[www.ansi.org](http://www.ansi.org)
5. **American Society of Mechanical Engineers, (ASME)**.  
Three Park Avenue, New York, NY 10016.  
Phone: 1-800-THE-ASME,  
[www.asme.org](http://www.asme.org)

## **WAYS TO REDUCE EXPOSURE TO DIESEL PARTICULATE MATTER**

1. Use low emission engines.
2. Use low sulfur fuel.
3. Use appropriate exhaust after treatment devices.
4. Make sure that you have enough ventilation in work areas.
5. Train diesel operators how to recognize hazards and to correctly operate and maintain equipment.
6. Read operation and maintenance manuals.
7. Look for black smoke, this indicates improper fuel to air ratio.
8. No unnecessary idling.
9. Keep engine and air cleaners clean.
10. Do not overheat the engine.
11. Do not operate the engine at high and low speed – No Lugging
12. No overpowering.